Maneuvering Mobility:
Measuring Multimodality in New York City's Selected Transit Hubs

A Thesis Presented to the Faculty of Architecture and Planning
COLUMBIA UNIVERSITY

In Partial Fulfillment
of the Requirements for the Degree
Master of Science in Urban Planning

by

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May 2018

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Abstract

The main purpose of this research is to answer the question of how New York City encourages multimodality through institutional and fare integration and how different transportation hubs within the city service multimodality through physical design. This research is primarily a qualitative study that heavily relies on direct field observations as well as reviews of the relevant literature. The analysis of this thesis is broken down into three main categories of multimodality integration: institutional, fare, and physical. The analysis of physical integration is focused on three transportation hubs: namely the Atlantic Terminal, the Wall Street Ferry Station, and the Harlem 125th Street Station. This thesis finds that New York City is a unique context in the organizations that are active in daily operations of public transportation. This institutional division of operations would consequently lead to low integration. While the presence of different transportation modes are continually present in proximity to each other, the ease of transfer most of the time is coincidental based on density and frequency of service and has little to do with intentional integration.

Acknowledgements

I would like to thank the wonderful faculty and students of the Columbia University Urban Planning Program who have nurtured and fed my passion for urban planning. They are the source of my motivation and inspiration. I am thankful to my advisor, Dr. Weiping Wu, who has guided me throughout this entire thesis process. I am especially grateful to my reader, Jonas Hagen, who has helped me further refine my thesis by providing his continuous insight and constructive feedback for the duration of this thesis.

I would like to thank Jonathan Son, for all his support and patience during all those long late night sessions of frustration and desperation.

Last but not least, I would like to thank my family, without whom I would not be here today if not for their unconditional love and support.

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1 Introduction

Cities are locations that hold and continuously produce a significant level of accumulation and concentration of economic activities. These economic activities are sustained through the connectivity and mobility of its people. Urban productivity is highly dependent on the efficiency of its transport system to move labor, consumers and freight between multiple origins and destinations. However, the larger the city becomes, the greater the potential for disruptions, particularly when this complexity is not effectively managed. One way of managing this agglomeration is through the effective diversification of mobility options and encouragement of multimodal travel options. The benefits of redefining and reallocating the limited street space within cities into a multimodal system also come with new challenges in terms of reducing automobile dependency as well as the integration of different planning organizations with different objectives.

There are a number of transformative transportation trends currently emerging, with new technologies that continue to rise as well as a shift in personal preferences regarding mobility. Trends show that younger generations are less interested in owning a car or getting their driving license (UITP, 2016). The pace of urban life is also increasingly rapid, especially in large cities such as New York City. Dense urban economies are dependent and rely on excellent connectivity, where residents are able to freely move whenever and wherever they need to. Cities are able to offer that by integrating mobility efforts which will substantially improve transportation networks and increase capacity and ridership. Not only urban developments, but market and technology-driven factors as well as political agendas are changing travel behavior trends which are now increasingly reflecting concerns about air quality, physical health and wellbeing. For example, municipalities and governments are actively developing mobility policies to favor active modes, encouraging citizens to walk and cycle more.

New York City

New York City continues to grow with a population that has swelled to over 8.5 million people. As New York prepares to meet the challenges of the 21st century, the issue of transportation overshadows the city's growth. Far from the problems of neglect and abandonment faced back in the 1970's and 1980's, New York City now faces the challenges of growth and rapid change: the ability to continue to provide the basic services and maintain the infrastructure that allows the city to thrive. However, underinvestment in transportation expansion and innovation, and insufficient maintenance and repair of roads, tracks, highways and bridges has meant that the city has been unable to keep the transportation networks growing to match the city's changing demographics. The current average commute for New Yorkers is noted at just over 40 minutes, about 14 minutes longer than the national average by the city website.

Since the early 1900's, subway construction has shaped development in the city. However, large scale upgrades, like the 2nd Avenue subway line, or information system upgrades are immensely expensive. Other new subway proposals which could increase transit access in the Bronx, Brooklyn, Queens and Staten Island would require extensive land acquisition and potential residential relocation. Integrated mobility is a transportation framework that provides a different approach to New York's challenges. It proposes that, in conjunction with building new infrastructure, coordinating existing systems can help to increase transportation capacity and connectivity. Cities like Hong Kong, Bremen, and Toronto have created overlapping networks of transportation modes (subways, buses, streetcars, bike-shares, car-shares, etc.) linked by easily accessible real-time information systems. For a city like New York, which already has tremendous amounts of transportation infrastructure in place, an emphasis on integration may help direct solutions that are relatively quick to implement, cost-effective and do not interfere with other long term infrastructure improvements.

This research aims to better understand the citywide strategies implemented in New York City in encouraging and enabling multimodal travel behavior through institutional, fare, and physical integration. It will examine at New York City as a whole and how the city has managed the continued growth and challenges of automobile dependency. It will also look at specific transportation hubs to study more closely integration through physical design. New York City was chosen due to the researcher's personal familiarity with the area and personal experience with the hubs. Ultimately this thesis attempts to answer the research question of how does New York City encourage multimodality through institutional and fare integration and how do different transportation hubs within the city service multimodality through physical design?

Research Design

This thesis seeks to investigate case-based studies and draws conclusions from planning practices in different locations. This research primarily a qualitative study that heavily relies on direct field observations as well as reviews of the relevant literature. The emphasis on secondary data is due to limitations in time, funding, and human resource.

The analysis is then broken down into three main categories of multimodal integration: institutional, fare, and physical. Institutional integration looks at the different providers of public transportation in the city and how they might complement each other, while fare integration seeks to study the different fare structures of these different institutions and how they might overlap one another. The analysis of institutional and fare integration is done through a city scale analysis. This part relies heavily on literature review as well as comparisons of other systems around the world for recommendations of improvement. The analysis is limited to the Long Island Rail Road (LIRR), the Metro-North Rail Road (MNRR), subway, bus, ferry, and CitiBike. Other modes are excluded from this analysis as these are the transportation systems most relevant present within three case hubs as detailed below.

Physical integration looks at design interventions within the transportation hubs themselves. The analysis of physical integration is focused on three specific case studies of existing transportation hubs. I visited and observed three different transportation hubs. The goal of these site visits are to assess the multimodality of the system in terms of access to other transit options. These observations were then supplemented with ridership data on the selected routes. Three sites are chosen of varying scales to represent differing levels of multimodality based on size and transportation mode focus. Having study locations in different neighborhoods allowed me to study distinct types of transit environments. The Atlantic Terminal was chosen as a case study of a major transit hub typology due to its significance as a transit node intersection between major rail and subway lines. The Wall St. Ferry terminal was chosen as a model for ferry terminal typology as it is the termination point of all NYC Ferry Routes. The Harlem 125th station was chosen to represent a rail-bus station typology due to its connections of a major airport route (LaGuardia) and Metro-North connection, as well as its proximity to existing and pipelined subway lines.

At each of the transit hubs, I applied a metric specifically for this analysis and noted where criteria were met or lacking. Due to the lack of publicly available tools for measurement regarding this topic, I designed the metrics specifically for this thesis. The variables considered were based on precedents of past theses as well as some grey literature such as the National Association of City Transportation Official's (NACTO) Transit Street Design guide and some Levels of Service guide books published by various local planning agencies. I also noted levels of service through physical observations which can be represented in pictures and maps. Observations were not reliant on specific time or days as the objects being observed were static, hence the time chosen to conduct these observations would not skew the data collected in any way.

Supplementary data was gathered from interviews with agencies involved within the planning process or professionals with expert opinions on the subject field. Interviews were open-ended and centered around broad questions regarding the process of planning specific strategies and their general insights on multimodality in the city. The interviews were recorded and then analyzed further to identify the overarching themes, to later be interpreted against the background research of other analysis. The recruitment of interviewees was done by the researcher through direct personal emails. City planning officials were reached with help of the researcher's past professors, including officials who were speakers in past classes attended by the researcher.

Due to the time constraints of this thesis and the limited availability of the targeted interviewee list, I was only able to conduct two interviews. Interviews were done with two New York City Department of Transportation officials with each interview lasting approximately 30 minutes. The questions discussed within the interviews are attached in the appendix of this thesis.

2 Literature Review

This literature review will briefly highlight research on automobile dependence, and multimodality. Understanding these key concepts will prove vital in understanding the policy implications of the findings of this thesis.

Automobile Dependence

Before the rise of private automobile ownership, walking, bicycling and public transit were recognized as important travel modes. However, for most of the last century, transportation planning has been automobile-oriented. The decades from the 1950s to the early 1990s were the halcyon years for highway planning and construction (Brookings, 2008). Automobile dependency is supported by the variety of advantages a private automobile offers such as on demand mobility, comfort, status, speed, and convenience. However, there exists extensive literature on the negative consequences of automobile dependence. Some of the more commonly known negative consequences are; social isolation, discrimination, expense, decline of small businesses, and effect on public health (Price, 2015). With this and the entry of new players entering the mobility market and residents are now reconsidering their mobility options, making personal car ownership less attractive.

Multimodality

To be efficient and fair, a transportation system must serve diverse demands. As Mumford (1981) has mentioned, there is no one ideal mode or speed: human purpose should govern the choice of the means of transportation. Multimodal planning refers to planning that considers various modes (walking, cycling, automobile, public transit, etc.) and connections among modes. Bak, Borkowski and Pawlowska (2012) define multimodal or intermodal to characterize transfer among two or more facilities, recognizing that the definition as applied to passenger transport has not been a definitive, agreed upon concept. The term has been more commonly used for goods movement transfers. Multimodal transportation often requires several modes of transportation.

When the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) was signed into law, it was hailed as a turning point in the history of surface transportation in America. ISTEA was envisioned as landmark legislation that would launch America into the post-interstate highway era. ISTEA also created the Surface Transportation Program (STP), which brought a new level of flexibility to the transportation funding process (Schweppe, 2001). This brought on more active planning in terms of catering to bicycle and pedestrian projects as they have grown eligible for programmatic federal transportation funding.

Multimodal connectivity is considered an important aspect of modern transportation systems since it allows transportation users to minimize their travel time and can improve quality of life. A good transportation system minimizes unnecessary transportation; it offers change of speed and mode to fit a diversity of human purposes (Mumford, 1981). Service connectivity is considered a necessary condition for acceptable public transit since it allows for transit service between origin and destination points and keeps travel time within users' schedules (Ceder and Teh 2010). Multimodality brings about a unique role in reducing car dependence in respect to the door-to-door mobility that private vehicles tend to offer. This role becomes especially important for those trips which a complete substitute to the car is not possible by active transportation modes such as walking or cycling. Mumford (1981) notes that each type of type of transportation has its special use and a good transportation policy must seek to improve each type and make the most of it. Hence the need for the integration of different transportation modes. In academic literature, the importance of multimodal transportation planning are studied extensively in relations to its benefits. Compared to the use of cars, intermodal travel offers prospects for alleviating seven problems: energy consumption, climate change emissions, road congestion, road accidents, poor air quality, lack of usable public space and noise from motor vehicles (Parkhurst Et al., 2010). In regards to safety, transportation systems with significant amounts of connectivity provide more options that can also improve the resiliency of systems and that could make responding to extreme events easier and more effective such as found in the University Transportation Research Center study (2014).

Multimodal connectivity also becomes beneficial in terms of economic benefits. Agglomeration economies, such as in NYC, are the benefits that come when firms and people locate near one another together in cities and industrial clusters. These benefits all ultimately come from transport costs savings. While the costs of moving goods may have declined dramatically during the last decades, the cost of moving people is still high. After all, time is a major input into human travel, and the value of time continues to rise as people become more productive (Glaeser, 2010). In the New York area, Shannon and Wells (2007) identified the disconnectedness of outlying areas populated by lower income groups in New York City, primarily focusing on the lack of connectivity between rail transit and bus service.

Integration

A large part of multimodal planning is the integration between different modes of transportation. Litman (2017) recommends best practices of multimodal transportation planning as needing to have integrated institutions, networks, stations, user information, and fare payment systems. This notion is also echoed by Parkhurst, Kemp, Dijk, and Sherwin (2012) when they refer to key attributes which are pivotal to the effectiveness of intermodal travel listed below.

- The extent to which vehicles of the different modes can be brought into physical proximity to minimize the effort and time costs of interchange distance.
- Temporal proximity within schedules of the different modes to minimize waiting times.
- Quality of interchange infrastructure, particularly in terms of ease of walking for the mobility impaired or those encumbered with luggage, and quality of the waiting environment,
- Low transaction costs, so that intermodal travelers perceive no additional financial or practical costs over and above what would apply to a single-leg journey, with the ideal being a 'multimodal ticket' priced at a similar level as a notional mono-modal means of making the same journey.
- The availability of information systems to update travelers, dynamic information can be particularly important for travelers using different modes which may be subject to different kinds of disruption.

The key takeaway for planning a multimodal system would be that transferring between modes will most likely produce some form of inconvenience to the passengers, hence the importance in integration lies in reducing this inconvenience as much as possible. Mees (2010) defines two basic conceptual approaches to creating a transfer-based public transport network: timed and random transferring. Within the random transferring network, frequent services are provided all day long on all lines in a 'grid' network that covers the whole service area. Transferring within this type of network would be possible in all directions at any place where two or more lines intersect. Timed transferring networks work differently where service is more sparsely provided but are timed to meet at designated transfer points, at intervals such as every 10, 15, 30, or even 60 minutes. Timed transfer networks tend to be laid out on a hub-and-spoke pattern, rather than a grid. This approach is less expensive to operate than a high-frequency random-transfer network, but harder to plan. It requires careful coordination of timetables, and reliable operations, since if one service arrives late at an interchange, the others must wait for it.

Austin (2011) reflects on the challenge of integrated planning where different modes are run by different organizations under separate contracts, but with minimal requirement to integrate fares and where there is a supervisory body which has relatively limited powers. Parkhurst et al. (2012) highlight that the creation of systems of intermodality requires cooperation from various transport actors, none of whom are strongly inclined to invest in it. Both of Mees' planning networks rely on cross-subsidy, since similar service levels must be provided across the whole network; this requires a pooling of revenues. This in turn means that a single organization must handle fare pooling, as well as planning routes and timetables to produce an integrated network of services (Mees, 2010).

One of the most important factors in the traveler perceiving a seamless interchange between transport modes is a charging structure which does not place a penalty on intermodality and enables quick and easy payment, ideally once for the entire journey (Parkhurst Et al., 2012). A fare system which is transfer friendly would most likely be a zonal system, where passengers are paying for the distance travelled rather than the number of transfers they make. Parkhurst Et al. further emphasize the importance of intermodal ticketing between public transportation modes. Intermodal ticketing in conjunction with a periodical ticket approach also keep the sustainability of running integrated networks. Having a unified fare system also allows for better public acceptance of service disruption, as long as disruptions are very rare. A periodical ticket helps passengers commit to public transportation, as Mees notes, “by the time the monthly expires, most people will have forgotten that their train was cancelled weeks earlier.”

The location and design of major interchanges are often of utmost importance for the functionality of public transport services. Austin (2011) argues that one way of approaching hub design is through developing large and iconic interchanges which makes transferring more appealing aesthetically. The creation of landmark hubs can be seen throughout New York City in locations like Grand Central Terminal and The Oculus. However, these design measures are both expensive to construct and maintain, hence unsustainable for smaller interchanges. Mees offers an alternative solution where the goal of interchange design is primarily making the distance covered between connecting services as short as possible. Where Nielsen (2005) recommends a five-step distance with protection from the weather in a clean and nice environment as the solution.

However, it is not enough to only physically locate the different transportation modes within each other, especially in cases where the infrastructure of different systems requires certain distancing. An important feature of interchange design is the provision of information of other modes of transportation. There has to be good directional signage between modes (including good lighting) and clear at-stop onward travel information at the stops / stations, including orientation maps. The best networks provide clear and comprehensive information at interchange points, enabling passengers to easily ascertain the transfer options available to them, where to walk and how long they will have to wait (Mees, 2010). Another important feature for interchanges of all sizes is the incorporation of retail and leisure-focused features, making the interchange an attractive place to wait for the tram, bus or train, and, to a certain extent, a destination in its own right (Austin, 2011).

An important takeaway from this literature review was the lack of publicly available tools or research that dealt with the measurement of intermodal integration. Some examples were found to briefly touch upon this subject in grey literature such as the Transit Street Design guide published by the National Association of City

Transportation Officials (NACTO) or studies of levels of service published by specific local agencies. Most academic research focuses on the individual modes rather than the integration aspect of design. There, however, seems to be a trend of research in the area within the European region as public agencies such as Transport for London publish design theme guides in response to transportation interchange design.

3 City Scale Analysis

This analysis will proceed with two main categories; institutional integration and fare integration. This city scale analysis will focus around the relationships that help provide the public transportation modes found within the three case study locations; Atlantic Terminal, Wall Street Terminal, and Harlem 125th Street Station namely: the Long Island Rail Road (LIRR), the Metro-North Rail Road (MNRR), the NYC Subway, the NYC Ferry, the NYC Bus, and CitiBike.

Institutional Integration

New York City is a unique context when dissecting the institutions that are active in its daily operations of public transportation. As shown in Table 1 below, different public transportation modes within the scope of this research are operated by different agencies. While some agencies are found under a larger umbrella agency, others operate independently. Within the three case study locations, I found three main actors of public transportation; the Metropolitan Transportation Authority, the NYC Department of Transportation, and the NYC Economic Development Corporation (see Table 3-1). These different agencies while seemingly integrated have little to no professional relationship amongst each other, hence any decision making remains largely independent. There is also another layer of complexity added by the state versus city agencies.

	Operator	Other Stakeholder
Long Island Rail Road	MTA Long Island Rail Road	MTA - State
Metro-North Rail Road	MTA Metro-North Railroad	MTA- State
NYC Subway	New York City Transit Authority	MTA- State
NYC Ferry	Hornblower Cruises	NYCEDC - City
NYC Bus	MTA Bus Company	MTA- State
CitiBike	Motivate (private)	NYCDOT - City

Table 3-1 New York City Transportation Operators

Historically, the development of what is now the public transportation system began most of its operations as privately owned companies, this includes subway and busses. The current subway system was once three separate companies, which were then bought and merged by the City of New York in 1940. In 1953, the State of New York created the New York City Transit Authority (which was later on renamed as MTA New York City Transit) as a separate public corporation to manage and operate all city-owned bus and subway routes. A large chunk of the New York City public transportation system is operated by the MTA which is a state governed agency, while other transportation modes are managed or have relationships with city governed agencies. This unique context is what presents challenges in the integration of transportation modes. Especially in terms of fare collection, where city and state agencies have separate revenue systems that is difficult to integrate.

Today, all of the subways and most of the busses are owned by New York City and leased to the MTA for operation. As a state agency, the governor of New York State has control over this authority and is able to appoint the chairman of the authority. The MTA is governed by a 17-member board. Members are nominated by the Governor, with four recommended by New York City's mayor and one each by the county executives of Nassau, Suffolk, Westchester, Dutchess, Orange, Rockland, and Putnam counties. The New York City Subways and Buses are comprised of two agencies under the MTA: MTA New York City Transit Authority and MTA Bus Company.

The New York City Department of Transportation (NYCDOT) is an agency under the government of New York City responsible for the management of most of New York City's transportation infrastructure. The agency is headed by a commissioner who is appointed by the mayor. The agency's main responsibilities include the maintenance of city streets, highways, bridges, and sidewalks, which includes expansion of the city bicycle network. The only transportation owned and operated by NYCDOT is the Staten Island Ferry, which is not covered within the scope of this research. CitiBike is operated by a private firm called Motivate, with a contract that is managed by NYCDOT. This relationship makes sense as NYCDOT is responsible for all the street spaces in NYC. The operation and expansion of CitiBike in many locations rely on the taking of sidewalks/street space/parking space to be converted to bike stations. The success of

CitiBike would also be highly dependent on the overall biking network of the city, which is managed by NYCDOT.

The New York City Economic Development Corporation (NYCEDC) is one of the newest stakeholders within the city transportation system. NYCEDC is a non-profit corporation formed in 2012 and charged with using the City's assets to drive growth, create jobs, and improve quality of life. It is important to note that NYCEDC, unlike NYCDOT, is not a city agency. The corporation is run by its president and has a board of directors, where the mayor is able to directly appoint its members and chairperson. Among its many services NYCEDC is responsible for developing New York City’s maritime infrastructure, which includes the NYC Ferry System.

Fare Integration

In this section we dissect the fare integration of six public transportation modes in the city. Due to institutional operation differences, not all NYC transportation modes are completely integrated in terms of fare payment. However, an attempt of integration is presented by the NYC Ferry with their identical pricing of $2.75 per ride to other in city transportation modes. Almost all public transportation modes covered in this analysis accept forms of payment through the MetroCard, the MTA’s automated fare collection medium, except for the NYC Ferry and CitiBike which are not affiliated with the MTA.

The MetroCard is able to hold dollar value as well as ride/time value and can be refilled and renewed once they expire. There is a $1.00 fee for the purchase of a new MetroCard.

Transportation modes under the MTA structure have slowly continued to grow more integrated over the years. Access to the subway is given through MetroCard swipes at the turnstiles present at each station entry. Access to busses differ between the regular busses and the Select Bus Service (SBS) busses. Usage of the regular MTA busses require passengers to board from the front entry of the bus, which allows the driver to collect on board payment. Payment is accepted using the MetroCard and exact change in coins. When using the MetroCard, a one-time free transfer is available for bus to bus or train to bus transfers within two hours of the first payment. SBS busses have distinct bus stops and include off board payment machines. This is to allow for faster boarding times within the bus service. Before the current MetroCard system, NYC subways and busses were fared through a single token system, where riders would insert a token for each ride taken. The change from the token system, phased out in 2003, to the MetroCard allowed riders to have free transfers between subway and bus rides.

Tickets for both LIRR and MNRR train systems can be purchased in advance and during train rides through the conductor. Purchasing a ticket on board the train is a cash-only transaction with a slight price difference. Purchasing tickets in advance can be done through several ways. The most traditional way is through ticketing windows at each station. Each station also comes equipped with ticket machines that also allow payment through the use of the MetroCard dollar value. Additionally, the MTA provides an online mobile ticketing app that allows passengers to purchase and use tickets directly from smartphones or mobile devices.

The MTA is currently working on different projects to further integrate their different modes in the near future. One investment that is ongoing involves a contact free system that has possibility of connecting with individual mobile devices. A large part of the investment will go into the purchase of new electronic readers for the subway turnstiles as well as busses. This venture is hoped to facilitate an easier way of reinserting credit within the fare “card” and a speed up of passenger boarding especially on busses. Another project is the LIRR Freedom Ticket, which when implemented will integrate LIRR tickets with the NYC subway and NYC bus system. The ticket will allow riders to buy one-way tickets, weekly, or monthly passes valid for both subway and LIRR trains. While fares will be more expensive than MetroCards, they'll likely be cheaper than purchasing both an LIRR ticket *and* a MetroCard.

Fare collection for ferry rides are on an independent system and is possible through their official website, their mobile application, ticket agents, or ticket booths and are payable by cash or card. The MetroCard is not valid for ferry ticket purchases. Transfers from the ferry to other transports requires additional fare charging. The CitiBike system also runs on an independent structure that works through a membership system. Riders are able to purchase different membership options through the CitiBike official website, mobile application, or directly on a CitiBike station machine. Payment is only accepted through debit or credit cards. Payments in form of cash and MetroCards are not accepted in this system.

Fare Pricing

Different transportation modes and different operators have generated various pricing structures within the transportation system. The LIRR and MNRR base their ticket prices on the distance traveled as well as on and off peak hours. The lowest per ride fare is still more expensive than other MTA operated modes of transportation. The NYC Subway, NYC Ferry, NYC Bus systems all have the same $2.75 flat fare pricing per ride. The different fare structures and payment methods is elaborated in Table 3-2.

	Per Ride	Weekly/Other	Monthly	Form of Payment	Notes
Long Island Rail Road	$3.25 - $29.25	$29.75 - $160.00	$190.00 - $500.00	MetroCard, Cash, Credit/Debit Card	Additional $5.00 lifetime permit for bike boarding Additional $1 for children age 5-11
Metro-North Rail Road	$5.00 - $28.00	$49.25 - $144.75	$154.00 - $455.00	MetroCard, Cash, Credit/Debit Card	Additional $5.00 lifetime permit for bike boarding
NYC Subway	$2.75	$32.00	$121.00	MetroCard	Bicycles are permitted on Subway trains at all times with no extra charge
NYC Ferry	$2.75	n/a	$121.00 $141.00 (with bike)	Cash, Credit/Debit Card	Additional $1.00 for bike boarding Children under 44" ride free
NYC Bus	$2.75	$32.00	$121.00	MetroCard, Exact change in coins	Foldable bikes permitted except on express busses
CitiBike	$12 per day (30 minute rides)	$24 per 3 days (30 minute rides)	$169 annual (45 minute rides)	Credit/Debit Card	n/a

Table 3-2 New York City Transportation Pricing

4 Case Study Analysis

The following sections aim to analyze the integration of different transportation modes through the physical design at each of the three selected transportation hubs. I will first provide background information on each transportation hub followed by the main takeaways from observations conducted for the study by the researcher and ending with conclusions from the observations. The three transportations hubs selected as case studies for this thesis are very different from one another in terms of size and context. For the diversity of research, each hub also has a different focus of different transportation modes. These differences are important in understanding the different approaches to intermodal integration.

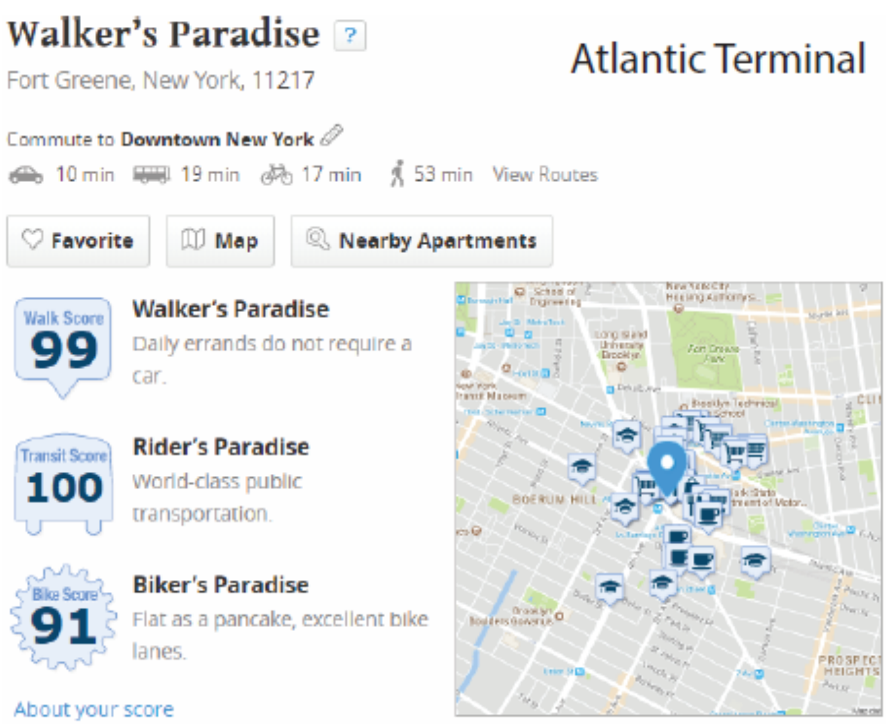

Figure 4-1-1 Walk Score of Atlantic Terminal
Source: https://www.walkscore.com

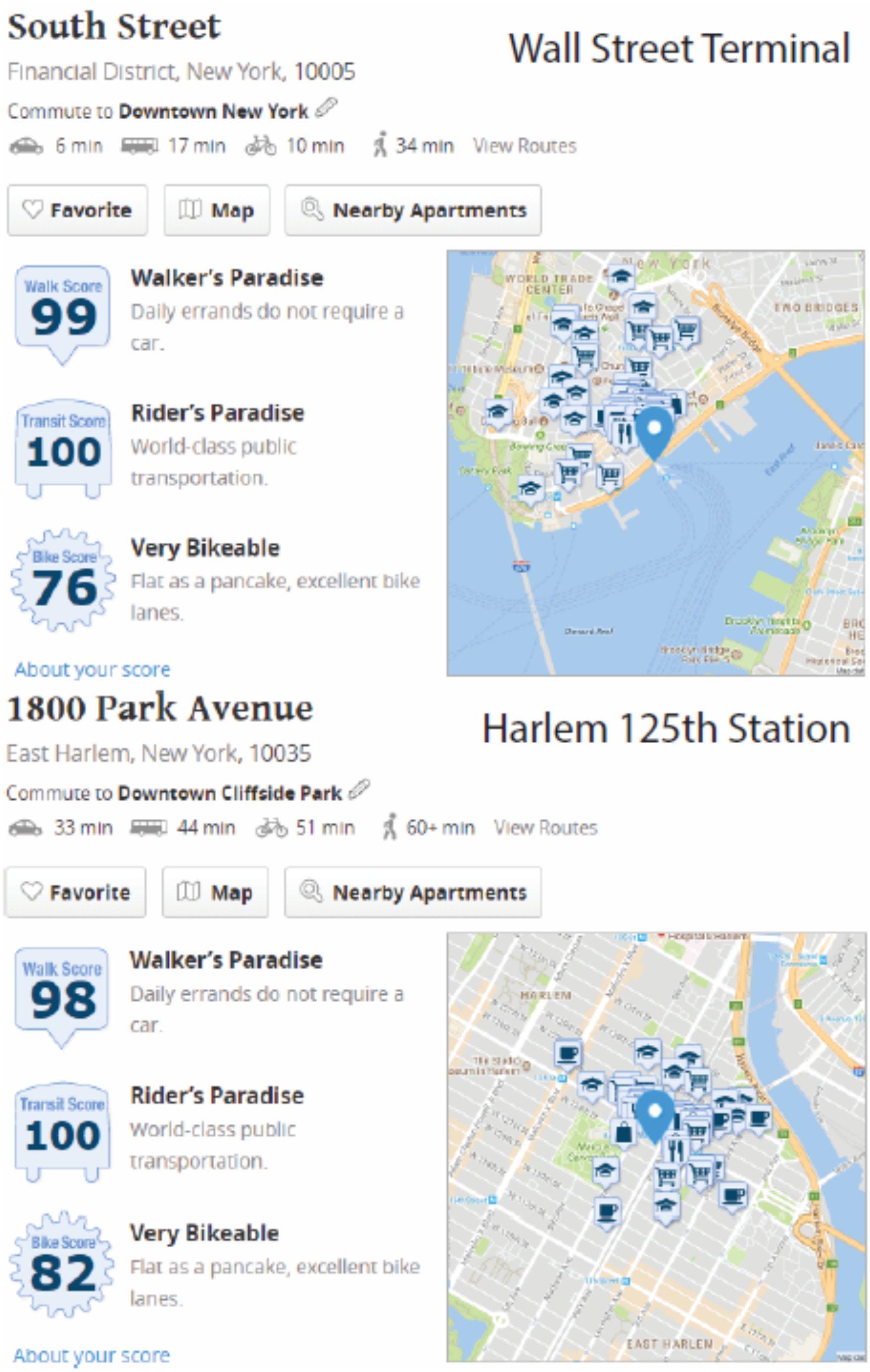

Figure 4-2-2 Walk Score of Wall Street Terminal and Harlem 125th Street Station
Source: https://www.walkscore.com

It is also important to note that in general, New York City is already developing in a direction that is much more pedestrian and bike friendly. The density and dependence of its residents on public transit network mixed with various policies targeting safety, such as Vision Zero, have reduced auto-dependence, most apparent in Manhattan where the infrastructure is supportive of this lifestyle. This general context is also reflected in Walk Score (Figure 4-1-1 and Figure 4-1-2), a publicly available tool to measure accessibility. Scores here are meant to reflect the number of amenities and services that can be accessed by walking for virtually any address in the U.S. as well as Canada and Australia. The company also provides scores for cycling and transit. Using this measuring tool, all three sites have been noted as a “Walker’s Paradise” with a score of 98-99 as well as a “Rider’s Paradise” with a transit score of 100. The level of bikeability varies within these three sites, which will more elaborated more in this section. While multimodality is growing strong in this city, the analysis will focus more on the integration of these modes within each transportation hub.

Atlantic Terminal

Figure 4-3 Main entrance of Atlantic Terminal

The Atlantic Terminal is one of New York City's major transit hubs located at the intersection of Flatbush Avenue and Atlantic Avenue in Brooklyn. The station's current terminal is the result of a six-year renovation that was completed in 2010, providing improved connections between the LIRR, subways, and buses. It is considered a leading transportation hub that is a major east west connector through Brooklyn. It is the westernmost Brooklyn terminus of the LIRR Atlantic Branch as well as the primary terminal for the Far Rockaway, Hempstead, and West Hempstead railroad branches. The subway station that is connected to this terminal is Brooklyn's second busiest subway station in terms of annual ridership, only behind the Jay Street - Metro Tech station and stands as New York City's 22nd busiest station based on the MTA 2016 annual ridership data. The terminal comprises of four levels; above ground which is an inaccessible light atrium, the street level which has the main exit and entrances and connects to the Atlantic Terminal Mall, the lobby mezzanine which has the main ticketing windows, terminal back offices, restrooms, as well as a waiting room, and lastly the platform level which connects to the trains. The terminal size itself is not too big, with a building footprint of approximately less than 10,000 sqft, which makes navigating through it quite simple. Ticketing offices are open at the same hours for weekday and weekend service, from 6 am to 10 pm.

Figure 4-4 Main stairway of Atlantic Terminal

Station entrances are abundant in this terminal. The main entryways can be accessed through the northern entrance at Hanson Place and the northwestern entrance at Flatbush Avenue. There are also two additional entrances that connect the terminal to the adjacent Atlantic Terminal Mall on the eastern sides. However, the main journey to the trains eventually converge and consist only of one large stairway with no alternate presence of escalators. The aesthetic experience of passengers might have been prioritized over comfort and ease of travel when looking at the design of the main staircase as seen in Figure 4-3. While the observations were made during a weekend afternoon, one may assume that the elevator must be working at overcapacity to facilitate children or elderly and other passengers carrying heavy luggage or bicycles. There are only two elevators, which are located right next to each other at the Hanson Place entrance. At the time of observation, the elevators were clean and well maintained. Based on my observations, the terminal overall is not overly passenger friendly. There is barely any seating available throughout the whole terminal. Limited seating is provided in front of the train platforms. While considering the number of passengers that come through this terminal, the official waiting area is also extremely small with a capacity of less than 30 people. Other than that, there are no other seating options available in the terminal. The waiting area itself is located immediately next to the main ticketing windows and surrounded with informational posters regarding trains services as well as real time information screens.

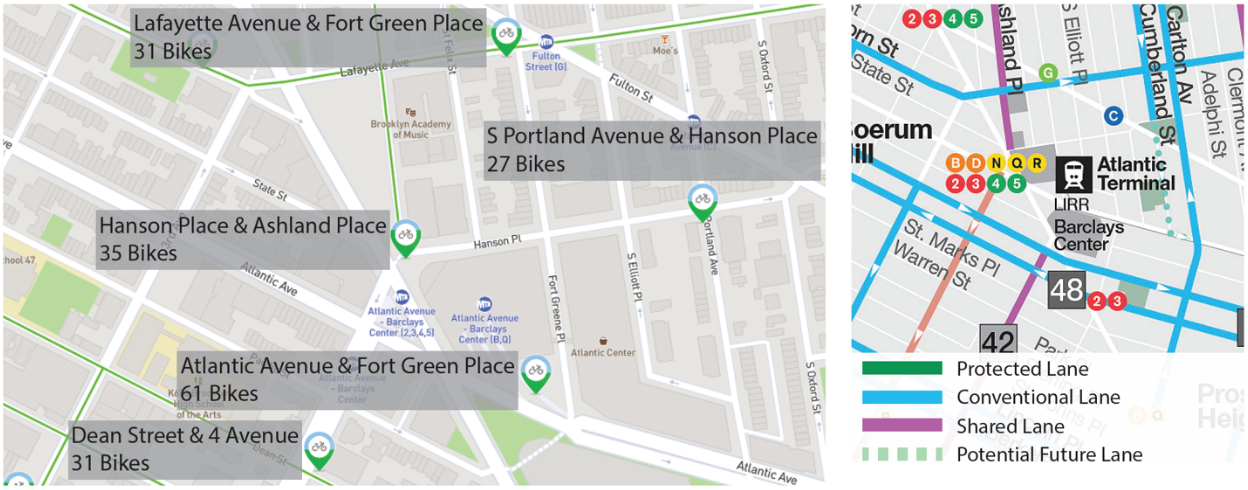

Figure 4-5 Bicycle path and CitiBike docks surrounding Atlantic Terminal
Source: CitiBike Station Map and the 2017 New York City Bike Map

Bicycling seems to be a major transportation mode that is designed to reach this terminal. As seen on the above Figure 4-4, the cycling network surrounding the terminal constitutes a mix of conventional bicycle lanes, shared lanes, as well as signed routes. A number of the DOT CityRack bicycle racks are present at each entrance, almost at parallel with the number of CitiBike docks. Within proximity of the terminal are a number of CitiBike stations, the largest station providing more than 60 bike docks. However, this provision may not seem to be fully intended for terminal passengers, as the terminal is also connected to a large shopping center, whose main entrance is closest to the Atlantic Avenue & Fort Green Place CitiBike station. It is also interesting to note that DOT's WalkNYC maps are not present on street within the terminal area. However, as CitiBike station maps provide similar information, while not immediately obvious to pedestrians, these maps may be able to substitute pedestrian wayfinding of the area.

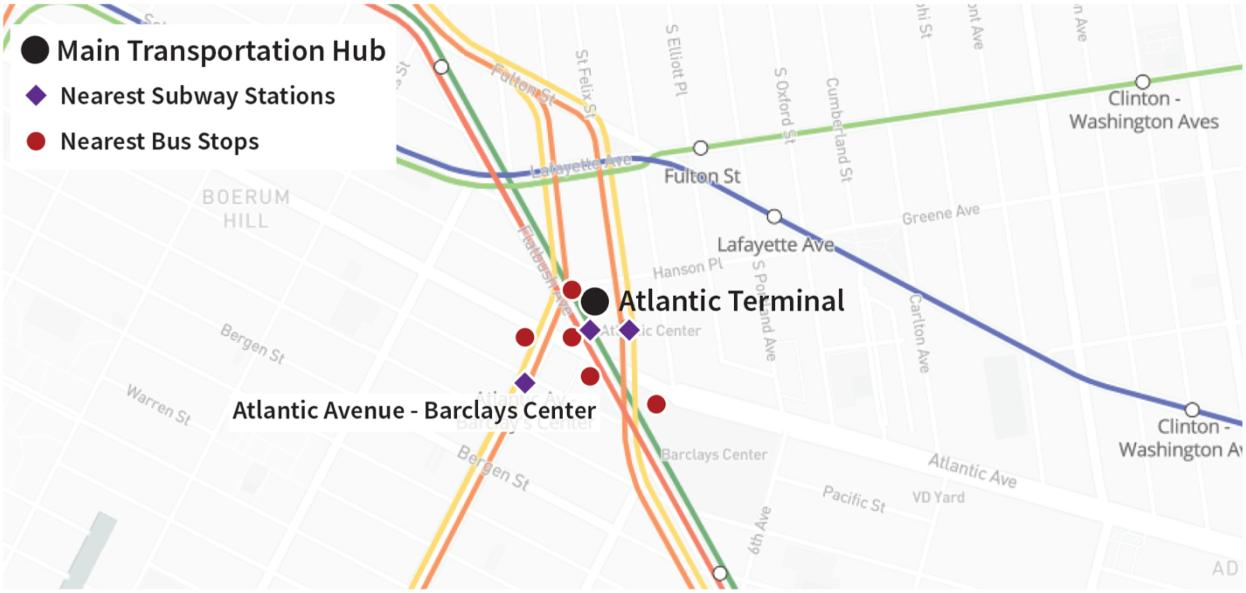

Figure 4-6 Subway stations and bus stops surrounding Atlantic Terminal

This terminal provides connections to a number of subway lines serving lower and midtown Manhattan. Connections to the 2, 3, 4, 5, B, D, N, R, and Q subway trains can be found at this terminal. The stations are mainly linked underground and are measured by the MTA as one “Atlantic Avenue-Barclays Center” with an annual ridership of almost 14 million riders. Transferring directly from the LIRR to the subway trains are quite convenient, as platforms are serviced on the same floor. However, due to differing fare systems between these two modes, passengers will need to access the subway ramps through fared turnstiles. Figure 4-5 also displays the locations of subway entrances as well as the nearest bus stops. There are five bus stops surrounding the immediate terminal entrances or less than a block away. The surrounding bus stops serve five Brooklyn bus routes operated by the MTA New York City Transit; B45, B63, B65, and

B67. While information regarding bus schedules are not easily found within the terminal itself, there is signage present informing passengers of the direction of transferring to busses as seen in Figure 4-6.

Figure 4-7 Atlantic Terminal bus signage

Direct car parking is not provided as part of the terminal. This terminal also lacks a main drop off or pick up point for passengers who might arrive or continue with taxis or other car-sharing services. The large intersection of major roadways where the terminal is located also make this location difficult to reach by private transportation. Riders transferring to or from private cars might have to consider street parking or taking advantage of the shopping center parking.

Wall Street Ferry Terminal

Pier 11 or the Wall Street Ferry Terminal is the termination point of all NYC Ferry routes. The terminal operates from 5 am to 9 pm on weekdays and from 8 am to 8 pm on weekends. The NYC Ferry service itself only formally began service recently in mid 2017, replacing the 2011 pilot East River Ferry service. The terminal is located on the east of South Street and FDR Drive just south of Wall Street. The ferry terminal has five landings, each with two berths, and is also used by four privately owned companies: SeaStreak, NY Waterway, New York Water Taxi, and New York Beach Ferry. The whole of the terminal is on ground level and mostly unsheltered, which makes navigating here quite easy, but doesn't provide shelter from inclement weather. As everything is built on a smooth paved ground level, it is easily wheelchair accessible.

Figure 4-8 Wall Street Ferry Terminal main house

The terminal has a standalone building of approximately 4,000 sqft as seen in Figure 4-7. Inside this main house are ticketing stations, the terminal back offices, restrooms, and a small food stand. This terminal has one main entry point from South Street. The area immediately surrounding the terminal entry point is extremely pedestrian friendly. The terminal entrance lies sheltered by the FDR highway and is fully bordered by a fully protected pedestrian way underneath the highway. The park scape unintentionally expands the waiting area of passengers, as boat activity is still visible from this area as seen in Figure 4-8 below.

Figure 4-9 Parkway in front of Wall Street Ferry Terminal

The terminal itself provides an abundant number of outdoor seating available for passengers which make the terminal seem very welcoming to its passengers. Some of these outdoor seating is covered with canopies for minimal weather protection. Passengers seeking full shelter can wait inside the main terminal. While seating capacity is limited inside, with three table settings, there is seating and tables comfortable for activities like work or consuming goods while waiting for the ferry. These can be seen in Figure 4-9.

While the general comfort of passengers is accounted for in the design of this terminal, information regarding other modes of transportation are nonexistent in this terminal. Information displayed around the terminal are dedicated only to ferry services with no direction to other continuing modes of transportation. Private advertisements and signage are intertwined between ferry schedules. The focus on passenger comfort within this terminal might also be due to the previous operations of fully private ferries within this pier.

Figure 4-10 Seating within and surrounding the main building of the South Ferry Terminal

As seen in Figure 4-10, while bus stops are located within two blocks of the terminal on Water Street, subway stations are located much farther. Busses running on these stops are the M15-SBS, X8, and X14. Free Downtown Red Bus Connector shuttles are also available in these stops, which are provided by a local business incentive district in its efforts to connect this area with the Battery Park neighborhood. The Wall Street subway station with services for the 2 and 3 train is a 7-minute walk away (0.3 mile). The Whitehall/South Ferry station serving the 1, N, R, and W trains is a 9-minute walk away (0.4 mile). Aside from distance, there is also a lack of wayfinding between the terminal and other modes. Within these subway stations, currently there is wayfinding for the South Ferry Terminal but not the Wall Street Ferry Terminal. This seems like a large missed opportunity as these two subway stations have a combined annual ridership of over 16 million riders with both stations performing in the top 60 stations of the overall city in terms of ridership.

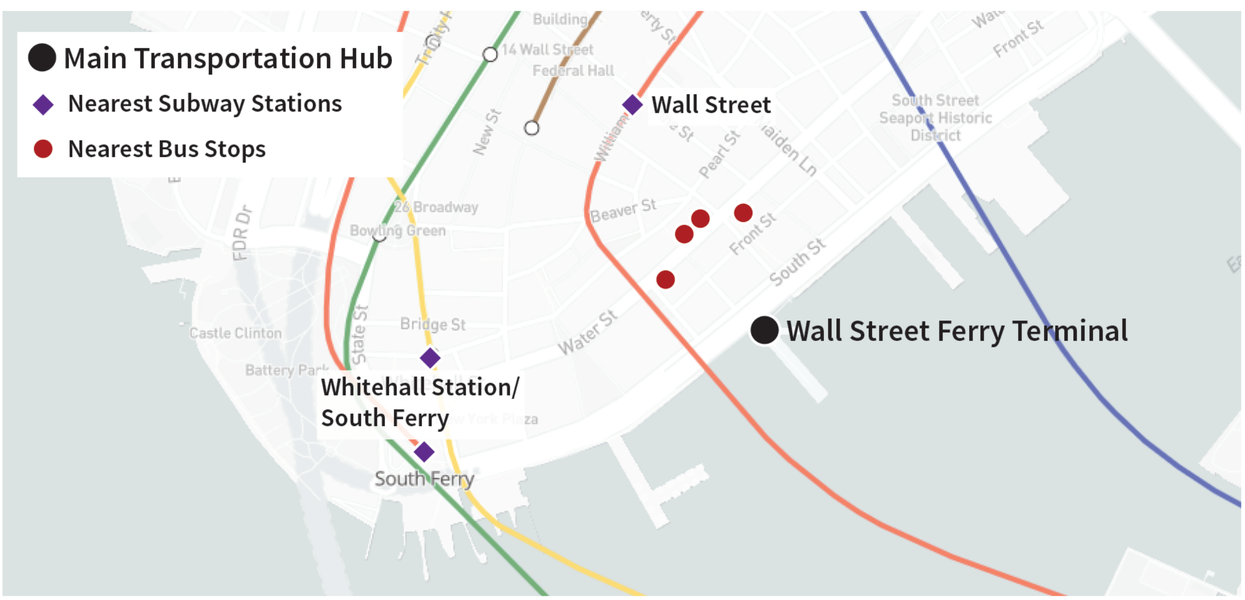

Figure 4-11 Subway stations and bus stops surrounding Wall Street Ferry Terminal

As seen in Figure 4-11, there is a protected bicycle lane noted by the green line with access points noted by the light green dots alongside the parkway, with a walk bike path underneath FDR as well as through Old Slip Street. Also noted on the map are potential future protected bicycle lanes along Water Street. CitiBikes are available immediately onsite with a capacity of 27 bikes at the South Street and Gouverneur Lane Station. A number of the DOT CityRack bicycle racks are also observed in the surrounding area. However, as this station borders a park, it is difficult to tell which function is the actual intention of providing these bicycle racks. Racks might be intended for park users and not ferry riders. Once again the DOT WalkNYC maps are not present to serve the terminal. However, as a CitiBike station is located onsite which provide similar map information, this maps may be able to substitute pedestrian wayfinding of the area. The nearest WalkNYC totem is located in the nearby Mannahatta Park.

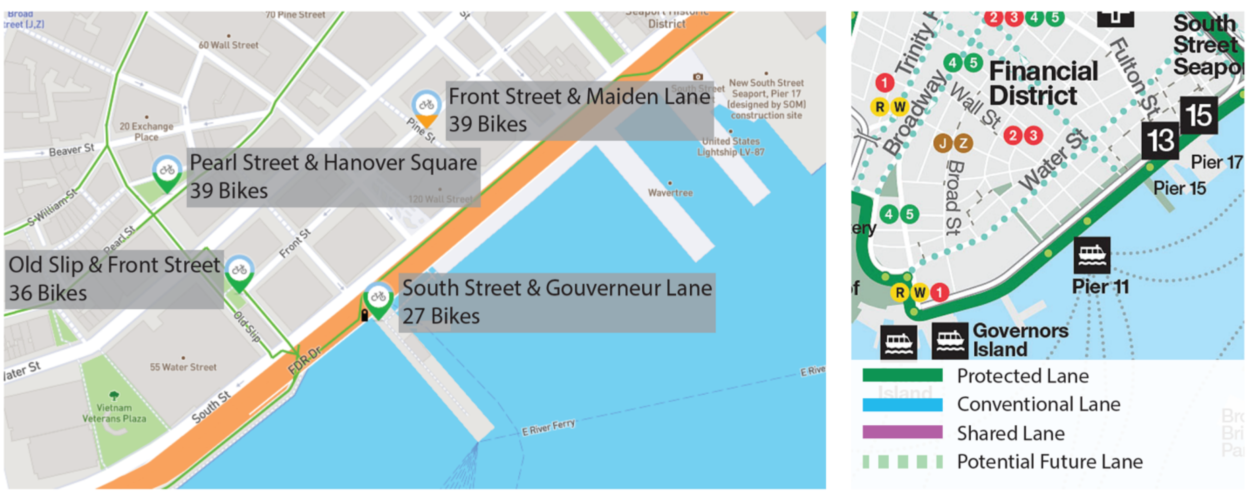

Figure 4-12 Bicycle path and CitiBike docks surrounding Wall Street Ferry Terminal
Source: CitiBike Station Map and the 2017 New York City Bike Map

While the terminal does not provide private parking, there seem to be a few private parking spaces available directly in front of the site underneath the FDR highway, it is unclear who operates this parking space as information is unavailable. In front of this parking space on South Street is also treated as an informal pick up/ drop off point. While there is no designated lane, taxis are seen to sometimes queue in this lane while waiting for passengers disembarking from the ferry.

Harlem 125th Street Station

The Harlem-125th Street Station is a Metro-North Railroad commuter rail hub located in uptown New York City. It is located in East Harlem, Manhattan on the intersection of East 125th street and Park Avenue. It is the only station aside from Grand Central Terminal that serves all three lines east of the Hudson River: the Hudson Line, the Harlem Line, and the New Haven Line. It is also dubbed as the "Uptown Grand Central" by local communities as it is a 10-minute non-stop train ride from Grand Central and is supported by the number of multiple train lines that pass this station.

Figure 4-13 Main hall of Harlem 125th Street Station

The station consists of two levels; the ground level with window ticketing, the station backhouse, MTAPD office, and other facilities and the upper platform level. The main access to the platform level is through one main staircase within the head house, there is also an external staircase that goes straight from the street to the platform. However, this path was closed for maintenance during the time of observation. There are two elevators available in the head house located right by the main 125th street entrance. The station is noted to meet ADA requirements for persons with mobility, visual, and hearing impairments. The features at this station include the elevators, tactile warning strips, and tactile signage. The facilities provided in this station include restrooms and a small food stand. The station operates daily from 6.40 am to 9.40 pm. The head house structure itself is quiet small with an approximate footprint of less than 16,000 sqft, which makes navigating the station quite straightforward. The station is located under the railway and lies in proximity to a number of health clinics in the area. Homelessness and loitering is also a prominent issue within this area, which makes the station uninviting and feel unsafe during certain parts of the day, especially at night time.

The main passenger waiting area lies within the building lobby as seen in Figure 4-12. Other than this area, seating is sparse within this station. A few benches are provided in front of the train platforms. While the platforms themselves are outdoor with a semi roofed embarking area, there are also small sheltered waiting rooms in front of the platform. However, there is no seating available within these small spaces. The overall design of this station seems to show little consideration for passengers who are elderly or might be traveling with children. Perhaps the served routes are meant to reach a majority of working commuters.

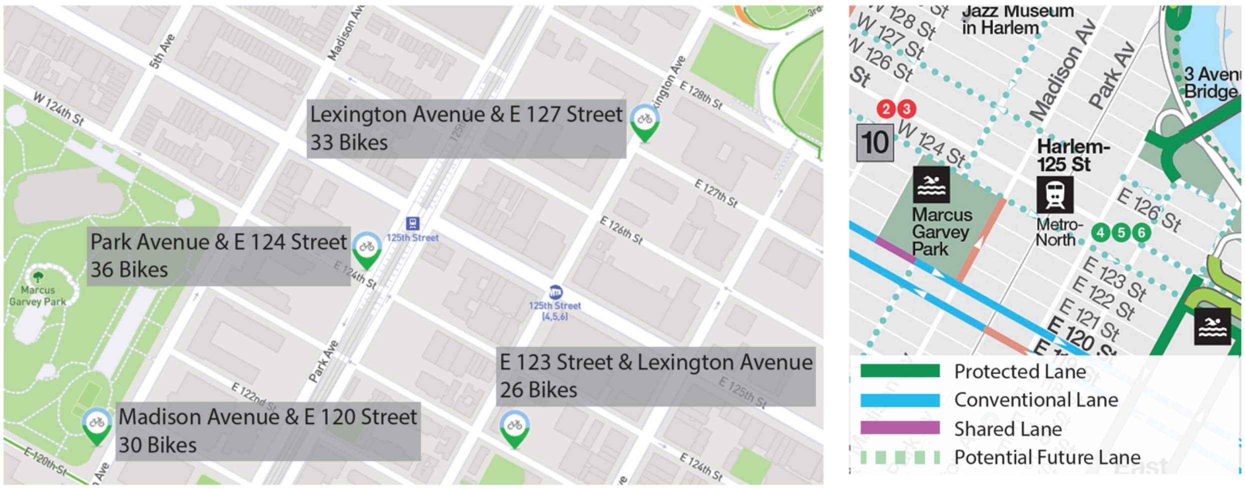

Figure 4-14 Bicycle path and CitiBike docks surrounding Harlem 125th Street Station
Source: CitiBike Station Map and the 2017 New York City Bike Map

Bicycle racks are present on the west and east side of the head house, though they are extreme limited and seem to be rarely used as seen on Figure 4-14. It seems that consideration for bicyclists were designed only recently, as can be seen in the above Figure 4-13. There are currently no forms of bicycle lanes present within the immediate surrounding of the station, with the exception of a short signed route alongside the Marcus Garvey Park. However, potential future protected bicycle lanes are noted in the pipeline. This development coincides with the newly present CitiBike stations which were only installed recently during the latter half of 2017. The closest station, Park Avenue & E 124 Street, is located a block away with a capacity of 36 bikes.

Figure 4-15 Unused bicycle racks on Harlem 125th Street Station

This station is located in proximity to the Lexington Avenue subway path which serves lines 4, 5, and 6. This 125th subway station is noted as the 35th busiest station in all of New York City based on the MTA 2016 annual ridership data. It is only one block away and seems to have a strong relationship with this train station as direct wayfinding signage is present within the Harlem 125th Street Station. The 2, 3 lines are also not far from this station, an 8-minute (0.4 mile) walk away. The significance of this station should increase in the future with the impending Second Avenue Subway extension with a terminus connecting to the Lexington Avenue line.

The availability of various busses is also an integral part of this station with connections to the M1, M98, M103, M35, M60, M100, M101, and BX15 bus routes. As noted in Figure 4-15 above, local westbound bus stops are less than one block away to the east as well as the special M60-SBS bus stop which lies right around the corner of the station. Eastbound bus stops are also one block away both to the east and west of the station. An important route connection to note is the M60-SBS route which connects directly to the LaGuardia Airport. While connecting bus routes are plentiful, there seems to be no intentional connectivity between the two modes. The journey to the bus stops are neither advertised by the station nor is the path designed as a holistic system which might consider covering from weather or displays of schedule information. The convenience of intermodal travel here seems to be merely coincidental. While the station displays information regarding subway operations as seen in Figure 4-16, there is no information regarding bus services.

Figure 4-16 Subway stations and bus stops surrounding Harlem 125th Street Station

Figure 4-17 Subway wayfinding within the Harlem 125th Street Station

In terms of other private modes of transportation, room for taxi queueing is available along the western side of the station as seen in Figure 4-17. The lack of a designated and designed drop off or pick up lane has great potential of disrupting traffic flows in front of this station. While there is no direct parking available for private cars, the station is surrounded by privately operated parking lots. On street hourly parking also line the 125th corridor, as it is a main commercial hub.

Figure 4-18 Traffic surrounding the Harlem 125th Street Station

5 Conclusion

Overall, the New York City transportation system has great potential of being a robust structure that supports multimodal integration. The density of the city itself creates opportunity for the presence of different modes of transportation to exist and reciprocally support each other. However, ultimately I found that the city itself does very little in terms encouraging and servicing multimodality through institutional and fare integration. In terms of institutional integration, each transportation agency seems to be solely focused on their individual transportation systems with little evidence of an attempt to integrate. This can be seen through each system's separate daily operations in terms of scheduling and/or station placement. Even transportation modes that are operated under one larger MTA umbrella are largely indifferent to each other in terms of operations. This disconnect is also exemplified in terms of fare integration. In terms of payment methods, the MTA allows for transactions of their different modes to be administered through the MetroCard. However, other transportation modes outside of MTA jurisdictions have no relationship whatsoever with the MetroCard. Different MTA transportation systems have different pricing structures where a relationship is only present between the subway and the bus system. Even this relationship is limited. Transferability is restricted to a time limit and made only available for rail to bus and bus to bus rides. Rail to rail and bus to rail transfers are not recognized as transfers, but as separate rides. While the pricing of the NYC Ferry system tries to mimic the subway and bus fare, there is no affiliation whatsoever between these two systems.

Figure 5-1 shows the scoring method used to analyze each transit hub. The scores range from 0-5, 5 being the highest achievable score. A score of 5 represents direct mode availability at the hub with access points fully covered from inclement weather. While a score of 0 represents a mode that is not available at the hub or within the surrounding area and no wayfinding towards the nearest facility location. Figure 5-2 displays the metrics measured at all three transit hubs with their respective modes and scores.

5	Directly serviced at the terminal with full coverage from inclement weather
4	• Located at the hub but lacks coverage from inclement weather or wayfinding • Located immediately around the hub or less than 5 minutes walking distance with wayfinding present at the hub
3	Located within 10 minutes walking distance with wayfinding present at the hub
2	Located within 10 minutes walking distance but lacks wayfinding at the hub
1	Located within proximity of the hub with no relationship to the hub.
0	Not available at the hub or the surrounding area with no wayfinding towards nearest location.

Table 5-1 Metric Scoring Parameters

	Atlantic Terminal		Wall Street Ferry Terminal		Harlem 125th Street Station	
Rail	✔ 5	Located within hub LIRR	– 0	n/a	✔ 5	Located within hub MNRR
Subway	✔ 5	Located within hub 2, 3, 4, 5, B, D, N, R, Q	– 0	Located within 10 minute walk 1, 2, 3, N, R, W	✔ 3	Located within 5 minute walk 2, 3, 4, 5, 6
Ferry	– 0	n/a	✔ 4	Located within hub NYC Ferry, SeaStreak, NY Waterway, New York Water Taxi, NY Beach Ferry	– 0	n/a
Bus	✔ 4	Located immediately around hub B45, B83, B65, B67	– 1	Located within 5 minute walk M15-SBS, X8, X14 Downtown Red Bus Connector	✔ 3	Located within 5 minute walk M1, M98, M103, M35, M60-SBS, M100, BX15
Taxi	– 0	n/a	– 0	n/a	✔ 4	Located immediately around hub
Personal Vehicle	– 1	Located immediately around hub: on street and private parking	– 1	Located immediately around hub: private parking	– 1	Located immediately around hub: on street and private parking
Bicycle	✔ 4	Located at hub entrance	✔ 4	Located at hub entrance	✔ 4	Located at hub entrance
CitiBike	✔ 4	Located at hub entrance	✔ 4	Located at hub entrance	✔ 2	Located within 5 minute walk

Table 5-2 Transit Hub Comparison

From the observations of three specific transportation hubs; the Atlantic Terminal, the Wall Street Ferry Terminal, and the Harlem 125th Street Station, I conclude that different transportation hubs within the city only somewhat encourage and service multimodality through physical design. While most transportation systems are active and present in the proximity of these hubs, little is done in terms of designing for ease of access between one another. Information is extremely sparse at these hubs regarding other transportation modes. The Atlantic Terminal and the Harlem 125th Street Station present some information regarding subway services as well as small wayfinding attempts to the nearest bus stations. Again, these small attempts only cover MTA operated modes of transportation. It is noted that all CitiBike stations are equipped with maps to easily locate other modes of transportation located within its proximity. The connectivity between different transportation modes in these hubs seem to not be intentionally designed for and are just coincidences and convenience of proximity. While each transportation hub further develops overtime and different modes of transportation are added, the priority is merely to be present within the proximity without actual design integration.

The biggest limitations for this study include the extent and comprehensiveness of the observations collected. The individual capability and time restraints of the researcher might have caused the researcher to overlook certain aspects of the hubs observed. Historical information regarding the development of these hubs that could have been proven useful to understanding their limitations are also limited. Other information limitations include observations of transportation performance measures with information such as ridership modal split and operation efficiency as well as the presence or impact of city or statewide policies on operational integration. The results of this thesis are limited in that they provide case-specific answers to a broader research question. To better answer the research question, information on a larger case sample size would be required. Additionally, the qualitative nature of the research process further complicates findings, as it is difficult to come to firm conclusions based on a subjective testimony.

A large basis of this study was the observation metrics that was designed by the researcher due to lack of existing tools in the planning field. Further studies should be conducted to design more in depth metrics and the impact of the presence of different transportation modes. Further study could also be done to examine the process of transportation hub design to understand the different stakeholder and priorities that are considered during the design process.

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Appendix

Observation Metrics

<u>Station/Terminal Design</u>

Size (sqft) :
Number of Entry Points :
Observations :

- Facilities and amenities
- Walkability: Sidewalk width, landscaping buffer, curb cuts, weather protection
- Disability access
- Signage and wayfinding
- Information regarding other modes

<u>Mode Availability</u>

Subway
Available/accessible yes / no
Distance from station/terminal ________ how many and which lines ________

Rail
Available/accessible yes / no
Distance from station/terminal ________ how many and which lines ________

Bus
Available/accessible yes / no
Distance from station/terminal ________ how many and which lines ________

Taxi
Available/accessible yes / no how many ________
Drop off at terminal yes / no

Personal Vehicle
Available/accessible yes / no
Off street facilities ▢ parking how many ________

Bicycle
On street facilities ▢ connected ▢ protected ▢ shared
Off street facilities ▢ parking how many ________

CitiBike Station yes / no how many ________
Distance from station/terminal ________

Interview Questions

General Questions

1. How is the division of transportation responsibility within the city?
2. How does NYC manage different institutions that operate different modes of transportation?
3. What efforts have been made to integrate different modes of transportation?
    - Fare
    - Institutional/Operational
    - Infrastructure
4. What are the considerations used or analyzed in designing for intermodal behavior? How was community input integrated into this process?
5. How would you describe the role of different stakeholders in the issue of multimodal travel behavior? (developers, state/city agencies, communities)

Case Study Questions

1. Are there specific stations or transportation modes that are put as priority?
2. What are the steps/process for improving specific stations or transportation modes?